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Drivers of Reverse Logistics Activities: An Empirical Investigation

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Abstract

Nowadays, most of the companies are interested in the activities that support sustainable environment. Because, the rapid increase of the industrial activities and uncontrolled consumption of natural resources cause environmental problems. Here, the responsibility of the companies is to redesign their activities in order to prevent those problems. Besides, the companies encounter with the pressure both from government and consumers that they must reorganize operational activities such as raw material supply, distribution and production in an environmental friendly way. Based on this scope, reverse logistics and its drivers were explained in this research. Drivers of reverse logistics from the producers' perspective were analyzed in house appliance industry in Turkey. The research was carried out in two firms which are among the largest companies in the house appliance industry. The results were obtained through a questionnaire from the top-level managers and engineers that work in the dishwasher, refrigerator and oven factories. To determine the factors affecting reverse logistics activities of house appliance producers, a hierarchical structure was composed from the literature review of the reverse logistics. The data was analyzed by analytical hierarchy process, a multi criteria decision making method. According to the results of the research, there are significant differences of the factors that affect producers' reverse logistics activities between both firms.

Keywords: Reverse Logistics; Drivers of Reverse Logistics; Analytic Hierarchy Process

1. Introduction

The rapid increase of industrial activities and uncontrolled consumption of natural resources cause environmental problems inevitably. Because of this situation, most of the companies are handling environment friendly activities that support sustainable development. In order to fulfill this objective, reorganization of daily activities of a firm, such as raw material supply, production, distribution, storage or logistics, are crucial to a firm's success. In this context, the purpose of this study is to examine the main drivers of reverse logistics (RL) activities which is a fairly new concept that emphasizes the environmental perspective of logistics. RL deals with the returned, unused, products or unused raw materials in a reverse channel of distribution which is called reverse flow. Generally reverse flow starts with the final customer and ends with the producer that is completely the opposite of the traditional flow of logistics activities. The framework of the study is based on the producer's perspective to RL activities. Regarding the drivers of the RL activities, three main factors can be classified as the drivers of RL which are economics, legislation and corporate citizenship. In the study these drivers are presented in a hierarchical design in order to assess the importance of each

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factor. The study is organized as follows. First, detailed information concerning the scope of RL and reverse flow are provided. Then, the drivers of RL according to the hierarchical design of producer's perspective in two firms (Firm A and Firm B) operating in home appliance industry in Turkey are examined. Finally, research findings and discussions are presented.

2. Background of Reverse Logistics

The concern for the environment led companies to be interested in environmental aspects of their operations (Thierry et al., 1995). From their perspective, there are a series of activities which needed to be integrated with environmental perspective, especially affected by the relations with its social and politic environment. Mainly of these activities, they have to consider the environmental effects of logistics. Because the distribution function of logistics cause the majority of environmental problems, especially air and noise pollution (Wu; Dunn 1995).

In researches, it is possible to come across with several terms referring to reverse logistics such as "reversed logistics, return logistics, retro logistics, and reverse distribution" (Melissen; De Ron 1999). This new concept mostly has been associated with recovery but it differs in most ways such as the way, the time and the structure of product flow. The reuse of products is practiced for many years because of providing economic benefits. Also another motivation for the recovery of materials reported by Fleischmann (1997) was waste reduction.

In all situations, there is a reverse flow opposite to the conventional supply chain flow. Guiltinan and Nwoköye (1975) and Ginter and Starling (1978) were the first researches to mention the terms "reverse channels or reverse flow". In the eighties, Lambert and Stock (1981) used the term of "reverse logistics" for the first time (Rogers; Tibben-Lembke 2001). The main focus of the researchers in those years was to emphasize the movement of the products by defining it as "going to the wrong way".

In the early nineties, Stock (1992) points out that one of the first definition was made by The Council of Logistics Management (CLM) as "the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal" (De Brito and Dekker, 2004).

Pohlen and Farris (1992) and Kopicky et al. (1993) broadened the definition of CLM by adding the movement of the products and flow of information from consumer to producer in the distribution channel. Rogers and Tibben-Lembke (1999) included the goal and process of the term and defined reverse logistics as "the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal" (Rogers; Tibben-Lembke 1999, p. 2).

The redesign of the supply chain to handle effectively product returns is important to be capable of remanufacture, recycle or waste disposal. In an effective supply chain management of the reverse flow can reveal some resources that were not previously considered (Dowlatshahi 2005). Besides the beginning point of the product return is considered as consumption point which the voluntarily involvement of the consumer is essential in reverse logistics (Diáz; Álvarez; Gonzalez 2004).

In reverse logistics concept there are several activities the companies carry on with returned products or materials and they need to identify the possible destination of returned product (i.e. the production line, the distribution, reassembly line) Due to the diversity of products in the reverse flow, there are various alternatives of reverse logistics activities namely as; reutilization, repair, renovation, reprocessing, cannibalization or recycling (Thierry et al., 1995).

Direct reuse; some of the returned products may be reused without involving in production process instead with slight cleaning and limited repair. Examples of such products are the means of transportation; pallets, containers, bottles or boxes (Diáz; Álvarez; Gonzalez 2004).

Repair; the products are returned by the consumer/user to have it back in working order. The producer fixes or replaces the broken parts if necessary. It requires limited effort. Generally quality of repaired products perceived less quality those new products (Thierry et al., 1995; Diáz; Álvarez; Gonzalez 2004).

Refurbishing; Returned products are brought up to specified quality level. The product is disassembled into modules and after those modules are inspected they are fixed or replaced. Also upgrading the technology of the product can be associated with refurbishing. After the process the quality of the product is improved substantially (Thierry et al., 1995; Diáz; Álvarez; Gonzalez 2004).

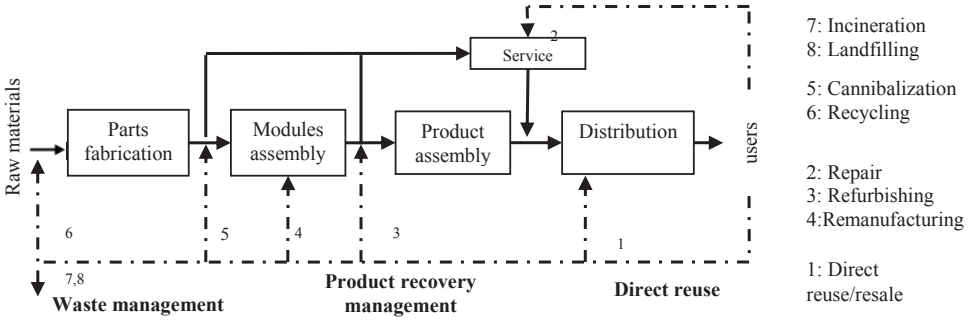

Fig 1. Integrated supply chain (Thierry et al. 1995)

Remanufacturing; Returned products are carefully inspected, disassembled and broken or outdated parts are replaced with new ones. At the end of the process, the purpose is to increase quality standards. Additionally, repairable parts and modules also can be used after being fixed.

Cannibalization; the purpose is to recover limited parts of used products that are reused in other reverse logistics activities (i.e. repair, refurbish, remanufacture). There is no strict quality standard for cannibalization. It depends on the process where parts will be reused.

Recycling; in the previous processes the identity and functionality of returned products are retained as much as possible. But recycling reuses the materials in production of new parts, thus the identity of product is lost. *Incineration and landfilling*; the last alternative is to incinerate or landfill the returned products because of the limited capacity of waste yards. In case of providing no gain to the company even being involved in recovery process, it can be seen as an option.

3. Drivers of Reverse Logistics Activities

In reverse flow the varieties of product types effect reverse logistics practices. Reused packages, disposed computer equipment, unsold commercial goods, spare parts, packaging materials (Van Hoek 1999) are among these product categories. Besides the characteristics of returned products, companies hold to be responsible for the consequences of their activities (from raw material supply to after-sale services) and this responsibility are reinforced by legal and social enforcements. Moreover, companies own objectives like economic, corporate or marketing affect implementation of reverse logistics practices (Rogers, Tibben-Lembke 1998; Lee et al., 2000; Wu and Cheng 2006). In practice, the presence or absence of the factors are considered drivers or barriers to reverse logistics (Lau; Wang 2009).

Reverse logistics starts with the products moving back in the supply chain (De Brito and Dekker 2004). In this process there are two parties involved in reverse flow. The returner party initiates the returning with several purposes (i.e. product recalls, value recovery etc.) and the receiver party carries on activities with returned products to resell, redistribute, reuse, reprocess or recover remaining value.

In this research, focus will be on the driving forces of receiver perspective. Generally, the companies carry on reverse logistics because of the profit, obligatory forces or social pressure. According to this classification, the drivers are named as; economics, legislation and corporate citizenship (De Brito and Dekker, 2004).

3.1. Economic Reasons

Processing returned or used products provide substantial gains to the companies. In some cases, reusing the products can be a cheap raw material source and sometimes when the production of new products are much more

expensive than recovering, reverse logistics is considered as an option. For example, copy machine producers Xerox and Canon strive on recovery activities. According to the annual reports of Xerox in 1998, recovery and reuse of materials provided saving millions of dollars annually. Canon has two facilities that perform only recovery activities in America and England. By this means, in 1997 nearly 20 million cartridges were recovered (Fleischmann 2001).

In all recovery actions, economic benefits are related with direct and indirect gains. Decreasing the use of raw materials and waste materials, obtaining valuable spare parts and other financial opportunities like second hand market are among direct gains (De Brito and Dekker 2004).

Decreasing the use of raw materials; companies are not able to anticipate the amount and timing of product returns. It can benefit from the usable parts of returned products in the production of new products. Thus, the cost of new raw material supplies decrease.

Decreasing waste materials; because of the increase in environmental problems, customers impose strong pressure on companies to take environmental aspects into account. Thus, they will benefit from being environmentally friendly in production and be able to decrease waste materials and cost of waste disposal.

Obtaining valuable spare parts; the purpose is to regain the value still incorporated in a used product. Especially in the industries where product life cycles shorten day after day, it is possible to recover the whole returned product or economically valuable parts.

Other financial opportunities (second hand market); overhauled products may be used as spares or sold on secondary markets. In some situations, wastes of an industry are qualified in another industry such as metal scrap brokers collect the waste of steel producers and use them to gain economic benefit. However, the companies can also benefit indirectly by being involved in reverse logistics even there is no clear or immediate expected profit because of marketing, competition and strategic factors (De Brito and Dekker 2004).

Marketing objectives; companies are expected to be green in every aspect of their operations by society and government. Thus a 'green' image has become an important element in marketing strategies. A green image is not only producing green goods but also carrying out other activities environmentally responsibly. This objective can be as well part of a customer relationship strategy (De Brito and Dekker 2004). In a competitive industry environment, companies may be obliged to explore new options for take-back and recovery products to better meet consumer expectations. Also there is an opportunity to develop relationships in the business environment by expressing the environmentally consciousness image.

Competition drivers; the purpose is to prevent others getting the technology of the firm or preventing them entering the market. For example, IBM gives great importance on reverse logistics activities. They established a unit called GARS (Global asset recovery services) to manage the flow of returned products and to prevent the competitors having their used products (Fleischmann 2001).

Strategic drivers; many countries enforce environmental legislation and charging producers with responsibility for the whole product life cycle (Fleischmann 1997). Thus the companies have to take into consideration both the current laws and possible effect of future legislation in their strategic planning.

3.2. Legislation

The legislation driver refers to any jurisdiction indicating that a company should recover its products or take them back (Peters 2009). Since the strict legislations about the environmental issues express the extended producer responsibility, companies are entitled to recover their products or accept them back. Companies are holding accountable for the whole product life cycle anymore.

In some industries like automobile, the producers are obliged to take back the products. Especially in European Union, regulations such as End-of-life Vehicles Directive (ELV), Waste Electrical and Electronic Equipment Directive (WEEE), Restriction of Use of Certain Hazardous Substances Directive (RoHS), packaging and packaging waste directive dictates the prevention of waste and promotes the recovery of waste. In Turkey since 2009 the companies in electronic industry are subject to Waste Electrical and Electronic Equipment Directive. In the directive, the responsibilities of producers start with the new product design process, production methods and proceeds to the waste disposal.

Implementation of law in EU and Turkey are in national boundaries. But considering the globalization effect, the stringent legislations would also have an impact in the worldwide. Particularly, internationally operating companies need to assess the impact of legislation in their target market or existing foreign markets.

3.3. Corporate Citizenship

Corporate citizenship refers to the set of values or principles that an organization holds to be responsible with RL activities. The motivations behind the implication of RL activities lay on both being legally obliged and trying to establish an image the consumers desires as an environmentally responsible organization. Better customer services such as increasing the level of customer awareness for returning and refunding options, guaranteeing better services would affect company's image positively and provide potential benefit. The Japanese firm Fujitsu produces "green" products by developing a philosophy called "Green Life 21". Fujitsu places environmental issues at the top of management priorities with the philosophy. By this means, sixty six products of one hundred are green and they achieved to produce the first energy saving computer (Diaz; Alvarez; Gonzalez 2004).

4. Research Method

In case of a vast range of alternatives it is unlikely to consider the range of choices thoroughly. Since there are many drivers of reverse logistics as it has been explained previously, one of the multiple criteria decision making methods were used to assess the importance of each factor. In comparison with others multi criteria decision making methods, AHP has the relative ease for user and it is possible to evaluate both qualitative and quantitative factors together (Kahraman et al. 2004, Taliscali; Ercan 2006). Saaty (1977) indicates that AHP simplifies the cognitive demands placed on decision-makers by restricting the simultaneity of choosing from numerous options to pairwise comparisons (Davies 2001).

4.1. Defining the problem and sample

The research problem was based on the fact that the high return rate of electronic products and their economic values after recovery. Nearly %90 of the electronic products can be recovered due to the valuable and recoverable parts such as steel, iron, plastic, glass they compose (Rauch; Eckelman; Gordon 2007). A sample of two companies, Firm A and Firm B, those are characterized by being among the biggest 500 companies according to the list of Istanbul Chamber of Commerce published every year, has been identified for inclusion in this research. Sensibility of the executives was considered and the company names were not expressed in the study. The products are chosen among the durable goods classified in International Standard Industrial Classification of All Economic Activities (ISIC Rev 2. and ISIC Rev 3.) as refrigerator (R), dishwasher (DW) and oven (O).

4.2. Designing the hierarchy

The main drivers of RL activities adopted from the study of De Brito and Dekker (2004) for producers were presented in a hierarchical design where the drivers are explained in detail the previous section. These drivers were transformed into a questionnaire to provide a better understanding of pairwise comparisons for the executives and engineers of the household appliance companies that work in the refrigerator, dishwasher and oven factories.

4.3. Making judgments based on pairwise comparison

The decision makers in each factory compared the drivers for reverse logistics with respect to other drivers using the comparison scale that has values from 1 to 9. The receiver perspective has nine pairwise comparisons in total. The decision maker scored the drivers according to their judgments. The instructions to answer the questionnaire were given in detail at the beginning of the questionnaire.

4.4. Comparison of F_A and F_B

From the hierarchy of producer's perspective, weighted vectors of main criteria (economic reasons, legislation and corporate citizenship) are represented in Table 3. According to the table, Firm A's main criterion is economic reasons in consideration of dishwasher (W_{ER}= 0,51). But Firm B's main criterion for dishwasher is corporate citizenship

(W_{CC}=0,41). For refrigerator the main criterion of Firm A is legislation (W_L=0,67) and Firm B's main criterion remains unchanged with the weighted vector of 0,62. Ultimately, Firm A's main criterion is economic reasons for oven (W_{ER}=0,63). Firm B has a weighted vector of 0,40 for the criterion corporate citizenship considering oven.

Table 2. Weighted vectors of main criteria

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{ER}	**0,51**	0,26	0,13	0,10	**0,63**	0,33
W_L	0,36	0,33	**0,67**	0,28	0,26	0,27
W_{CC}	0,13	**0,41**	0,20	**0,62**	0,11	**0,40**

The other matrices of pairwise comparisons and the weight vector of each matrix are given in Tables 3-10.

Table 3. Weighted vector of sub-criteria of economic reasons

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{DG}	**0,88**	**0,87**	0,34	**0,83**	**0,83**	**0,75**
W_{IG}	0,12	0,13	**0,66**	0,17	0,17	0,25

Table 4. Weighted vector of sub-criteria of legislation

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{NL}	**0,90**	**0,80**	**0,80**	0,20	**0,80**	**0,75**
W_{IL}	0,10	0,20	0,20	**0,80**	0,20	0,25

Table 5 Weighted vector of sub-criteria of corporate citizenship

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{CV}	**0,88**	**0,85**	**0,75**	**0,83**	**0,80**	0,14
W_{GPV}	0,12	0,15	0,25	0,17	0,20	**0,86**

Table 6. Weighted vector of sub-criteria of direct gains

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{DURM}	**0,51**	**0,52**	0,24	**0,54**	**0,48**	**0,59**
W_{DWM}	0,21	0,28	0,14	0,24	0,23	0,25
W_{OVSP}	0,16	0,15	0,07	0,13	0,20	0,10
W_{OFO}	0,12	0,05	**0,55**	0,09	0,09	0,06

Table 7. Weighted vector of sub-criteria of indirect gains

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{MO}	**0,68**	**0,71**	0,11	0,08	**0,68**	**0,54**
W_{CD}	0,19	0,09	0,35	**0,63**	0,19	0,35
W_{SD}	0,13	0,20	**0,54**	0,29	0,13	0,11

Table 8. Weighted vector of sub-criteria of marketing objectives

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{GI}	**0,83**	**0,75**	0,17	**0,80**	0,14	**0,75**
W_{GRCS}	0,17	0,25	**0,83**	0,20	**0,86**	0,25

Table 9. Weighted vector of sub-criteria of competition drivers

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{PGT}	**0,86**	**0,85**	**0,80**	0,14	0,15	**0,75**
W_{PEM}	0,14	0,15	0,20	**0,86**	**0,85**	0,25

Table 10. Weighted vector of sub-criteria of strategic drivers

	DW		R		O	
	F_A	F_B	F_A	F_B	F_A	F_B
W_{PFL}	**0,90**	**0,87**	**0,86**	**0,88**	**0,85**	**0,90**
W_{IFL}	0,10	0,13	0,14	0,12	0,15	0,10

The combination of priority weights for sub criteria, criteria for each product to determine priority weights are given in Table 12-14. Differences between criteria considering the product are shown in bold.

Table 11. Summary combination of priority weights of dishwasher

Criteria	Weighted Vector of Criteria		W_{DW}	
	F_A	F_B	F_A	F_B
Main criteria	**ER**	**CC**	0,51	0,41
ER	DG	DG	0,88	0,87
L	NL	NL	0,90	0,80
CC	CV	CV	0,88	0,85
DG	DURW	DURW	0,51	0,52
IG	MO	MO	0,68	0,71
MO	GI	GI	0,83	0,75
CD	PGT	PGT	0,86	0,85
SD	PFL	PFL	0,90	0,87

Table 12. Summary combination of priority weights of refrigerator

Criteria	Weighted Vector of Criteria		W_R	
	F_A	F_B	F_A	F_B
Main criteria	**L**	**CC**	0,67	0,62
ER	**IG**	**DG**	0,66	0,83
L	**NL**	**IL**	0,80	0,80
CC	CV	CV	0,75	0,83
DG	**OFO**	**DURW**	0,55	0,54
IG	**SD**	**CD**	0,54	0,63
MO	**GRCS**	**GI**	0,83	0,80
CD	**PGT**	**PEM**	0,80	0,86
SD	PFL	PFL	0,86	0,88

Table 13. Summary combination of priority weights of oven

Criteria	Weighted Vector of Criteria		W_O	
	F_A	F_B	F_A	F_B
Main criteria	**ER**	**CC**	0,67	0,62
ER	DG	DG	0,66	0,83
L	NL	NL	0,80	0,80
CC	**CV**	**GPV**	0,75	0,83
DG	DURW	DURW	0,55	0,54
IG	MO	MO	0,54	0,63
MO	**GRCS**	**GI**	0,83	0,80
CD	**PEM**	**PGT**	0,80	0,86
SD	PFL	PFL	0,86	0,88

5. Conclusion

Despite of the variety of the definitions, the main drivers of RL activities are not well understood yet and can only be investigated through empirical research. The motivation behind the research was the need to provide empirical data to further the knowledge of the drivers behind reverse logistics activities by assessing the importance of each factor.

First, a review of reverse logistics literature was explained in detail covering the reverse logistics activities. After reviewing the drivers of reverse logistics in the existing literature, to be able to realize the goal of the study, the major drivers were identified as economics, legislation and corporate citizenship referring to the research of De Brito and Dekker (2004). An empirical analysis was carried out in the household appliance industry with the aid of the decision makers in the Firm A and Firm B. The data was analyzed using analytic hierarchy method that is accepted as a useful tool for decision makers in case of a vast range of alternatives. The main reason for choosing household appliance industry was presence of economic value of the products even they are at the end of product life. Besides it is possible to recover ninety percent of their parts after being returned to the producer.

The analysis results show that there are differences in terms of main factors, economic factors, legislation and corporate citizenship. In terms of main factors, mainly economic factors are primary criteria for F_A, where corporate identity is in all three products for F_B. When assessing the criterion of direct gains, decreasing the use of raw materials were expressed primarily by both firms. Given the criterion of indirect gains, marketing objectives of both companies said to be a priority. Considering marketing objectives, green image has predominantly selected. Preventing other companies to getting their technology was mainly the priority of both firms. Finally, for strategic drivers, getting prepared for future legislation was the choice of both firms.

The results of this paper can provide an insight of the importance levels of drivers to the decision makers of other companies in the industry. Besides, it is presumed that the presentation of the problem in a hierarchy would make it easier to assess the drivers of reverse logistics activities both the practitioners and academicians who are interested in this topic.

There are similar findings in the reverse logistics literature concerning the main drivers of actitivies. Zhu, Sarkis and Geng (2005) suggested several indicators for green supply chain management that can be also accounted of reverse logistics. According to their research, due to the environmental awareness, enterprises are being effected by regulatory, competitive and marketing pressures. Verstrepen et al. (2007) stated that majority of the reasons of return management was to accomplish marketing and economic objectives. Kumar and Putnam (2008) reported the drivers of electronic recycling as the current and anticipated environmental legislations, customer preferences for green products, corporate image and increasing waste disposal. Lau and Wang (2009) investigated the drivers of reverse logistics in consumer electronics industry in China and mainly legislation, corporate image, economic and marketing objectives were found to be important. Hernandez, Marins and Rocha (2009) identified the indicators of corporate performance in automobile industry taking into consideration reverse logistics activities. The results shows that the important factor is economic, followed by corporate citizenship and marketing objectives. Mollenkopf, Frankel and Russo (2011) identified the drivers to create value by the means of return management. From this perpespective, economic reasons, marketing objectives, corporate objectives are among the value drivers.

Limitation of this study is mainly analyzing one industry in one perspective. So, generalizing the results is not possible to other industries. But the developed hierarchy may be also applied to other industries as well. Also, the factors may vary across the industries and the model may be developed with extensive brainstorming sessions and taking into consideration of expertise and knowledge within the organizations. A possible future research can be carried out in different sectors where the importance level of drivers may change.

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Appendix. Hierarchical Design